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(71) Applicant: Bridgestone Corporation
10-1, Kyobashi 1-Chome Chuo-Ku
Tokyo 104 (JP)

(72) Inventor: Ushikubo, Hisao
110-3-403 Hanakoganei 6-chome
Kodaira City, Tokyo (JP)

(74) Representative: Whalley, Kevin et al
MARKS & CLERK 57/60 Lincoln's Inn Fields
London WC2A 3LS (GB)

(54) Pneumatic radial tires.

(57) In a pneumatic radial tire usable for running at very high speed, the tread comprises zigzag main grooves (1a, 1b) extending circumferentially of the tire between a tread end (T) and the center circumference (0) of the tread, and lateral grooves (3a, 3b) extending from the tread ends (T) across the main groove (1a, 1b) in a direction towards the center circumference. Each main groove (1a, 1b) is repeatedly comprised of a first element (Y_1) inclined with respect to the center circumference (0) and a second element (Y_2) crossing the first element and extending in common with the lateral groove.

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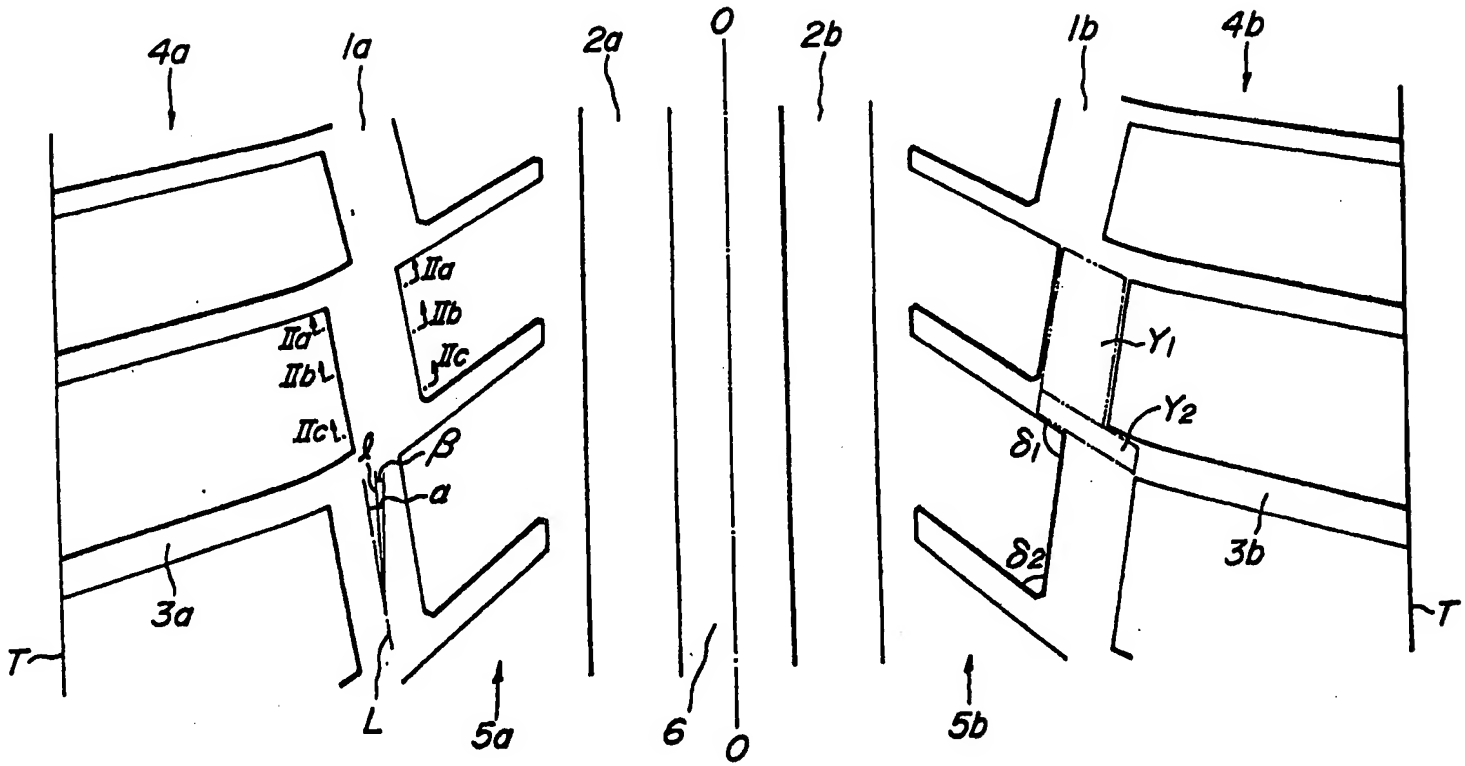
FIG_1


4a
1a
2a
O
2b
1b
4b
IIa
IIb
IIc
IIa'
IIb'
IIc'
β
a
Y1
Y2
δ1
δ2
3a
3b
T
L
5a
6
O
5b
T

PNEUMATIC RADIAL TIRES

Recently, passenger cars can stably be run at a super-high speed exceeding 240 km/hr with the completion of expressway network and the technical reform of the passenger car, and consequently it is demanded to develop tires having sufficient performances to the running at the super-high speed, i.e. tires having high drainage property and cornering performances at the super-high speed running and excellent uneven wear resistance.

This invention relates to a pneumatic radial tire for passenger cars, and more particularly to a radial tire having a herringbone type tread pattern and an aspect ratio of not more than 0.6 and being durable to super-high speed running.

In the tire of this type, as a tread having particularly an improved drainage property, there is known a so-called unidirectional pattern comprising a plurality of relatively wide circumferential grooves arranged along the central circumference of the tread, and plural lateral grooves extending from the tread end across the circumferential grooves so as to focus to the central circumference, in which the ground contacting of the same lateral groove is gradually conducted outward from a portion near to the tread center during the running under a load.

In such a tread pattern, the lateral groove slantly crosses with the circumferential groove, so that corner parts of an island portion defined by the lateral groove and the circumferential groove at the side of the same circumferential groove has obtuse angle and acute angle. Since the corner part having the obtuse angle is high in the rigidity as compared with the corner part having the acute angle, it is apt to be worn, and hence uneven wear is caused in the island portion in the circumferential direction. Such an uneven wear becomes remarkable in the island portion sandwiched between the circumferential grooves and located near to the tread center because the island portion located near to the tread end falls down toward the tread center in the cornering at high speed.

It is, therefore, an object of the invention to provide a pneumatic radial tire having an improved uneven wear resistance even in the unidirectional pattern having excellent drainage property during the high speed running.

The inventors have found that in order to avoid the aforementioned uneven wear, it is advantageous to take a rigidity balance in the circumferential direction of island portion, that is, it is advantageous to zigzag arrange the circumferential groove crossing with the lateral groove and approach the cross angle between the circumferential groove and the lateral groove to a right angle. However, it has been found that the zigzag arrangement of the circumferential groove newly brings about a disadvantage of extremely degrading the drainage property guaranteed by the circumferential groove disposed along the circumference of the tread. The inventors have made further studies on the drainage property in the tread pattern including zigzag arranged circumferential grooves and found a means for improving the drainage property, and as a result the invention has been accomplished.

According to the invention, there is the provision of a pneumatic radial tire comprising a cylindrical crown portion, a sidewall portion extending inward from each end of the crown portion in radial direction, a radial carcass extending from one of the sidewall portions through the crown portion to the other sidewall portion to reinforce these portions, and an inextensible belt layer and a tread successively arranged outside the carcass on the crown portion in radial direction ; said tread being provided with a main groove zigzag extending between a tread end and a center circumference of the tread in circumferential direction and a lateral groove extending from the tread end across the main groove so as to focus to the center circumference ; said main groove being repeatedly comprised of a first element slantly extending with respect to the center circumference and a second element extending to cross with the first element in common with the lateral groove ; and said first element being provided with a groove bottom extending at an inclination angle with respect to the center circumference smaller than an inclination angle of a groove opening portion in the vicinity of tread surface with respect to the center circumference.

The invention will be described with reference to the accompanying drawings, wherein :

Fig. 1 is a developed view of an embodiment of the tread pattern according to the invention ;

Figs. 2a to 2c are sectional views taken along lines IIa-IIa, IIb-IIb and IIc-IIc of Fig. 1, respectively ;

Fig. 3 is a developed view of a main part of another embodiment of the tread pattern according to the invention ;

Figs. 4a to 4c are sectional views taken along lines IVa-IVa, IVb-IVb and IVc-IVc, respectively ; and

Fig. 5 is a developed view of the conventional tread pattern.

In Fig. 1 is shown a main part of the tread in the pneumatic radial tire according to the invention. This tread is divided into a pair of longitudinal rows 4a, 4b each comprised of blocks located near to the tread end T, a pair of deformed rib rows 5a, 5b located near to the center circumference or equator O and a rib 6 located at the central portion of the tread by a pair of main grooves 1a, 1b zigzag extending substantially along the center

circumference O of the tread and located at both sides with respect to the center circumference O, a pair of circumferential grooves 2a, 2b extending at both sides with respect to the center circumference O in the central portion of the tread and in parallel to the center circumference O and many lateral grooves 3a, 3b extending from the tread end T across the main groove 1a or 1b so as to focus to the center circumference O in a herringbone fashion. The tire having such a unidirectional pattern is used by mounting onto a vehicle so as to meet the focusing direction of the lateral groove with the rotating direction of the tire.

Although one main groove is arranged at one side of the tread in the illustrated embodiment, the main groove may be arranged at one side of the tread within a range of 1-4. When plural main grooves are arranged between the tread end and the center circumference O, the depth of the main groove near to the center circumference O may preferably be made deep.

It is preferable that the angle of the lateral groove 3a, 3b with respect to the center circumference O is 50-90° at a region ranging from the tread end T to the main groove 1a, 1b and 20-70° at a region ranging from the main groove 1a, 1b to the circumferential groove 2a, 2b, in which the latter angle is always smaller than the former angle. Furthermore, it is possible that the width of the lateral groove is gradually increased from the center circumference O toward the tread end T or the groove depth is equal to or less than that of the main groove.

Each of the main grooves 1a, 1b is repeatedly comprised of a first element Y_1 slantly extending toward the tread end T with respect to the center circumference O and a second element Y_2 crossing to the first element Y1 and extending in common with the lateral groove 3a or 3b. The second element Y_2 uniformly extends in form of general U or V shaped section likewise the lateral groove.

On the other hand, in the first element Y_1, the groove opening portion near to the tread surface is inclined so as to increase an angle α between center line L in the width of the main groove and the center circumference O, while the groove bottom portion is formed so that an angle β between a center line ℓ and the center circumference O is made smaller than the angle α or the angle β becomes preferably zero. The angles α and β are preferable to be α : 5-15° and β : 0-10°, respectively.

As a result, the main groove indicates a zigzag form at the groove opening portion and a straight form extending substantially in parallel to the center circumference O at the groove bottom portion.

In the first element Y_1, the difference in the form between the groove opening portion and the groove bottom portion as mentioned above can be achieved, for example, by gradually increasing the inclination of the groove wall near to the tread end in the focusing direction of the lateral groove. That is, as shown by sections taken along lines IIa-IIa, IIb-IIb and IIc-IIc of Fig. 1 in Figs. 2a to 2c, the groove wall is formed so that an angle of groove wall near to the tread end with respect to a normal line of a profile of the tread surface drawn on an edge of an opening of the groove satisfies a relation of $\gamma_1 > \gamma_2 > \gamma_3$. On the other hand, the groove wall near to the center circumference is formed at a constant inclination angle γ_0, in which the angle γ_0 is set to be approximately equal to γ_3. Moreover, the inclination of the groove wall may take the continuous change as mentioned above or a stepwise change having bending point(s).

As the structure of the first element Y_1 in the main groove, an embodiment shown in Figs. 3 and 4 is advantageously adapted in addition to the above illustrated embodiment. In the embodiment of Figs. 3 and 4, the groove wall near to the tread end is gradually inclinated toward the side of the tread end in a region extending in the focusing direction of the lateral groove around a center in the longitudinal direction of the first element (see Fig. 4b) and also the groove wall near to the opposed center circumference is gradually inclined toward the side of the tread end, while both the groove walls are gradually inclined toward the side of the center circumference in a region opposite to the focusing direction.

Although each of the above tread patterns is symmetric with respect to the center circumference, it is possible to shift the pitch of the pattern at both sides of the center circumference to each other in the circumferential direction of the tire, and further the pattern may be unsymmetric with respect to the center circumference.

Furthermore, the other structure of the tire according to the invention may be the same as in the conventional tire.

That is, the carcass is at least one ply (3 plies at most) wound around a bead core from inside of the tire toward outside and containing fiber cords such as rayon fiber cord, nylon fiber cord, polyester fiber cord or the like arranged substantially in a direction perpendicular to an equator of the tire (radial direction). The belt is comprised of at least two main belt layers each containing inextensible cords such as steel cord, aromatic polyamide fiber cord or the like arranged at an angle of 10-35° with respect to the equator of the tire, cords of which layers being crossed with each other, and at least one auxiliary belt layer containing heat-shrinkable cords such as nylon cord or the like arranged substantially in parallel to the equator of the tire over a full width of the main belt layer. The auxiliary belt layer is formed by spirally winding a ribbon comprised of plural cords along the periphery of the main belt layer. Then, the tread is disposed on the belt.

Although the illustrated tire has a symmetric tread pattern with respect to the equator of the tire, the inven-

tion is naturally applicable to tires having a unsymmetric tread pattern.

In the conventional unidirectional tread pattern shown in Fig. 5, a force from the side of the tread end during the rotation of the tire, particularly force in the cornering is applied to a side groove wall 9 of an island portion 8 defined by a groove 7 along the center circumference O of the tread. When a lateral groove 3 is focused toward the center circumference O, corner parts 8a and 8b of the island portion 8 located at both ends of the side groove wall 9 have obtuse angle and acute angle, so that the difference in rigidity between the corner parts is caused to induce uneven wear.

On the contrary, in the tire having the zigzag arranged main groove according to the invention, the cross angle between the main groove and the lateral groove in the vicinity of the tread surface approaches to a right angle, so that the difference in the angle between the corner parts of the island portion can be reduced and the rigidity difference becomes very small.

In the tire according to the invention, the improvement of uneven wear resistance can be achieved by arranging the main groove zigzag as mentioned above. On the other hand, there is no groove straightly extending along the circumference of the tread, so that the degradation of drainage property may newly caused, but the drainage property can be sured by the following means.

That is, the groove bottom portion of the first element Y1 in the main groove is extended substantially in parallel to the center circumference O in a direction opposite to the direction in the groove opening portion, whereby the groove bottom portion of the main groove is substantially continued in form of straight to ensure the drainage property equal to that of the conventional technique.

The following example is given in illustration of the invention and is not intended as limitation thereof.

There was prepared a pneumatic radial tire having a tire size of 255/40 ZR17 according to a tread pattern shown in Fig. 1 and a groove structure shown in Fig. 2. This test tire had the following specifications :

(1) Main groove

[first element Y_1]
opening width of groove : 10 mm
depth : 8 mm
inclination angle α at groove opening portion : 10°
inclination angle β at groove bottom portion : 0°

inclination angle of groove wall γ_0: 10°, γ_1: 30°,
γ_2: 20°, γ_3: 10°

[second element Y_2]
length : 5 mm (width and depth are the same as in lateral groove)

(2) Circumferential groove

width : 12 mm
depth : 8 mm

(3) Lateral groove

width : 5 mm
depth : 7 mm
focusing angle with respect to center circumference O : 60°

(4) Island portion

angle of corner part δ_1: 115°
δ_2: 65°

Similarly, a comparative tire having the same tire size as mentioned above was prepared according to a

tread pattern shown in Fig. 5. Moreover, the angle of corner part in the island portion of this tire was δ_1 : 50° and δ_2 : 125°.

These tires were subjected to uneven wear test and drainage test to obtain results as shown in the following table.

Table 1

	Test tire	Comparative tire
Uneven wear resistance	120	100
Drainage property	100	100

Moreover, each test was made by mounting the tire onto a passenger car under an internal pressure of 2.5 kgf/cm^2 and running by means of a professional driver. The evaluation was represented by an index on the basis that the comparative tire was 100.

In the uneven wear test, the cornering of the car on a curved road having a radius of 50 m at a speed of 70 km/hr was repeated 20 times, and thereafter an amount stepwise worn at the block after the running was measured.

In the drainage test, the car was run from a dry road surface onto a wet road surface having a water depth of 10 mm in a test course having a radius of 90 m while gradually increasing the running speed from 50 km/hr to 70 km/hr, during which a change of lateral acceleration speed approached from the dry road surface to the wet road surface was measured.

As mentioned above, according to the invention, the improvement of uneven wear resistance in high-speed cornering can be attained without sacrificing the excellent drainage property, so that there can be provided tires suitable for not only middle to high speed running vehicles but also super-high speed running vehicles.

Claims

1. A pneumatic radial tire comprising a cylindrical crown portion, a sidewall portion extending inward from each end of the crown portion in the radial direction, a radial carcass extending from one of the sidewall portions through the crown portion to the other sidewall portion to reinforce the said portions, and an inextensible belt layer and a tread successively arranged outside the carcass on the crown portion in the radial direction; said tread being provided with a zigzag extending main groove (1a, 1b) located between a tread end (T) and the center circumference (0) of the tread in the circumferential direction and a lateral groove (3a, 3b) extending from the tread end (T) across the main groove (1a, 1b) so as to focus to the center circumference (0), said main groove (1a, 1b) being repeatedly comprised of a first element (Y_1) extending inclined with respect to the center circumference and a second element (Y_2) extending to cross with the first element in common with the lateral groove (3a, 3b), and said first element (Y_1) being provided with a groove bottom extending at an inclination angle (β) with respect to the center circumference smaller than an inclination angle (α) of a groove opening portion in the vicinity of the tread surface with respect to the center circumference.

2. A pneumatic radial tire as claimed in claim 1, characterized in that said lateral groove (3a, 3b) is inclined with respect to said center circumference (0) at an angle of 50-90° in a region between said tread end (T) and said main groove (1a, 1b) and at an angle of 20-70° in a region ranging from said main groove (1a, 1b) toward said center circumference (0), and in that the said latter angle is smaller than the said former angle.

3. A pneumatic radial tire as claimed in claim 1 or 2, characterized in that said first element (Y_1) is such that a cross angle (α) between a center line (L) of groove width and the center circumference (0) at a groove opening portion of said main groove (1a, 1b) near the tread surface is larger than a cross angle (β) between a center line (ℓ) of groove width and the center circumference (0) at a groove bottom portion of said main groove, and in that the said former cross angle (α) is 5-15° and the said latter cross angle (β) is 0-10°.

FIG_1

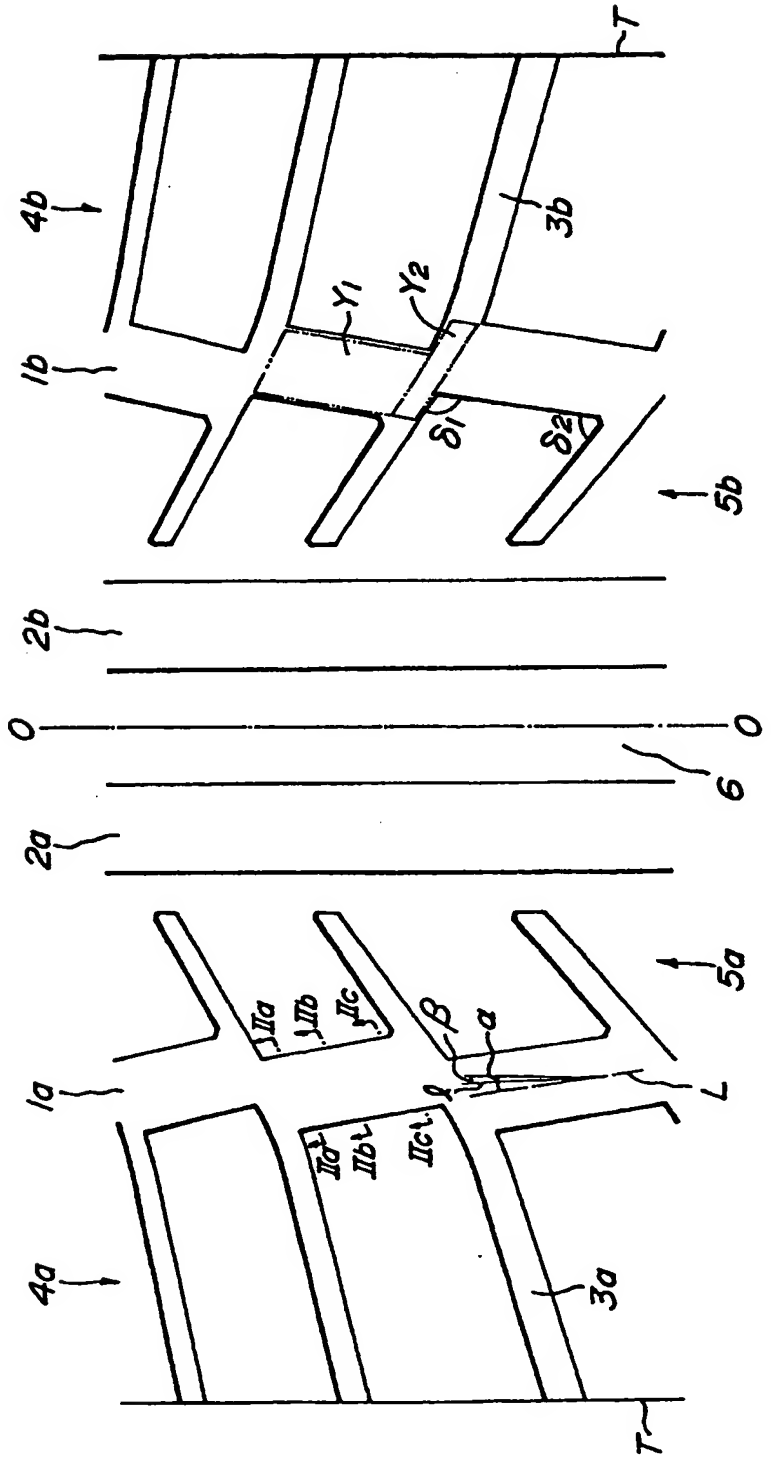

T
4b
3b
Y1
Y2
1b
δ1
δ2
5b
2b
O
O
6
2a
5a
IIIa
IIIb
IIIc
β
α
1a
7
IIa'
IIb'
IIc'
4a
3a
T

FIG_2a

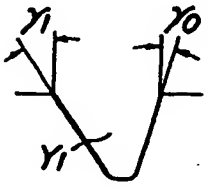


FIG_2b

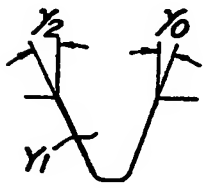


FIG_2c

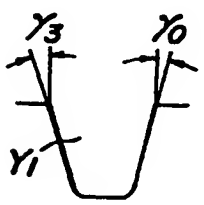


FIG_3

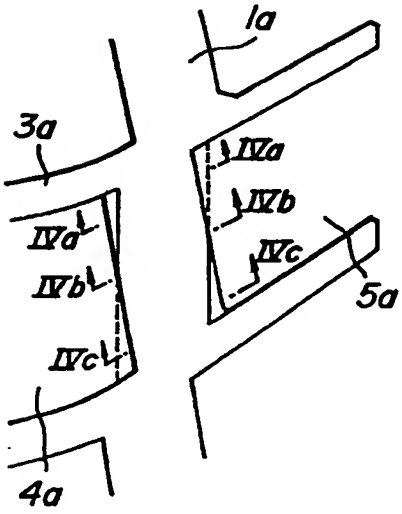


FIG_4a

FIG_4b

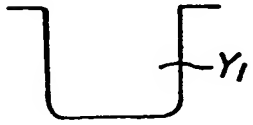
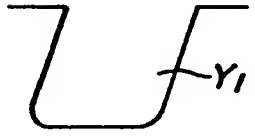


FIG_4c



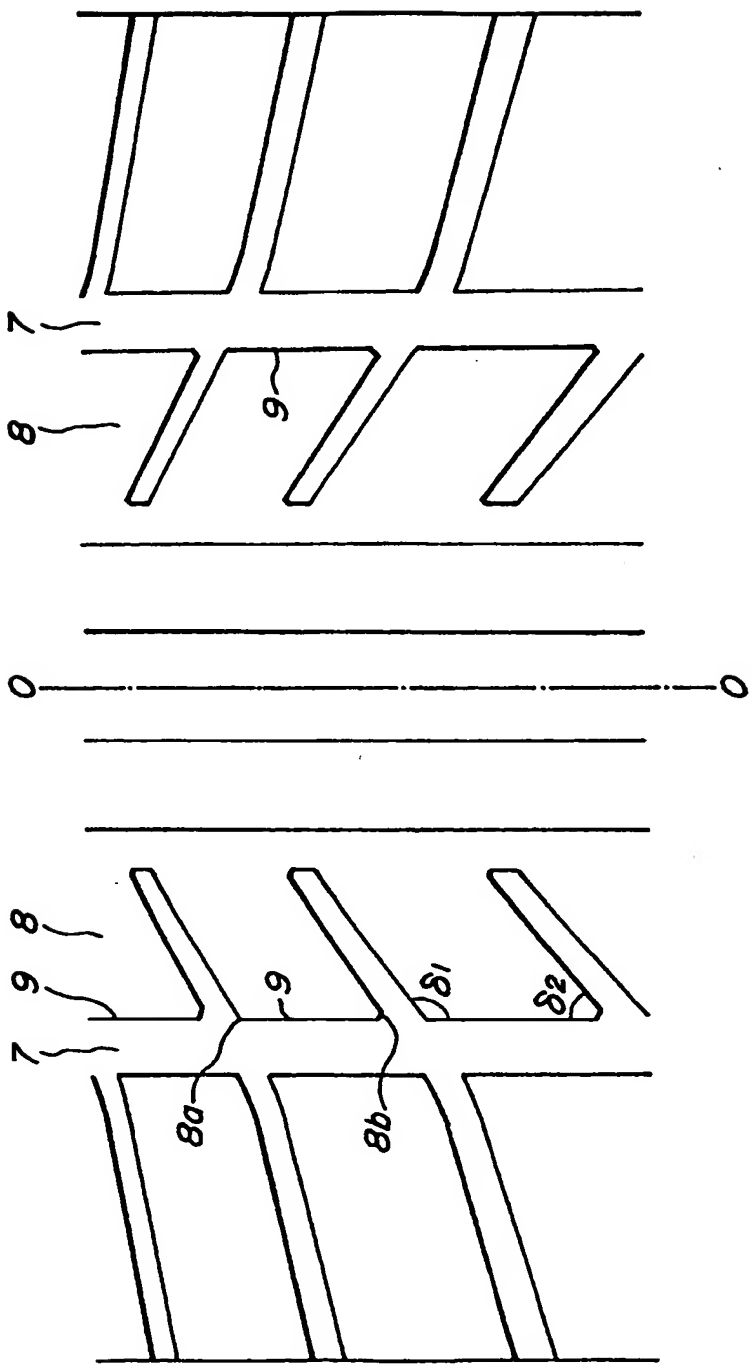


FIG. 5
PRIOR ART

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91300406.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP - A2 - 0 325 905 (SEMPERIT REIFEN AG) * Fig. 2; column 4, lines 10-26 *	1	B 60 C 11/04
A	--	2	
Y	DE - A1 - 2 912 546 (CONTINENTAL GUMMI-WERKE AG) * Fig. 1; page 5, line 15 - page 6, line 9 *	1	
A	--	3	
A	US - A - 4 796 683 (BRIDGESTONE CORPORATION) * Fig. 2-3c *	1,3	
A	-- US - A - 4 884 607 (THE YOKOHAMA RUBBER CO.) * Fig. 1-2c *	1,2	
A	-- US - A - 4 832 099 (BRIDGESTONE CORPORATION) * Fig. 1-3 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
	----		B 60 C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	20-03-1991	WIDHALM

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons

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